The Correlation Between Acacia Height and Pseudomyrmex Ant Colonization

Where the plants go, the ants go.

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Abstract

In this study, we attempted to determine if there was a correlation between the height of *Acacia collinsii* plants and the presence of *Pseudomyrmex* ant colonies. We hypothesized that the ant colonies would choose the bigger acacia plants, and that height was a deciding factor for the *Pseudomyrmex* ants. We measured height, calculated average thorn size, noted maturity of Beltian bodies, and looked for patterns within the acacias that ants had chosen to inhabit. While we assumed that ants would be choosing plants of larger in size, we found no correlation between height and the presence of *Pseudomyrmex* ants.

Introduction

There are multiple species of Pseudomyrmex ants, but our study focused solely on the *Pseudomyrmex ferruginea* ants. They are rust colored and approximately 6mm long. They are common occupants of *Acacia collinsii* and thrive anywhere from the dry lowlands of Colombia to around Acapulco and Tampico. While other species of *Pseudomyrmex* inhabit acacias exclusively in open sun or deep shade, *Pseudomyrmex* ferruginea is able to inhabit both environments (Janzen, 1983).

The process for a colony of *Pseudomyrmex* to find and inhabit a new acacia tree needs to be precise. It begins with the queen leaving the parent acacia 1-2 hours before dawn. She flies to the tallest object nearby and releases a pheromone downwind. By this time, a group of males have already begun flying upwind towards the queen. The males need to leave early to avoid being eaten by wasps; if they leave later, they would visible to the wasps by the light of dawn. When they reach the queen, she mates with one of them. Afterwards, she leaves the tree and sheds the male, who may never be able to mate again. She then pulls or bites off her wings, as they were only necessary for the dispersal and mating processes, and continues to search for a new acacia on foot. When looking for a plant to begin her new colony, she specifically searches for

plants with green or purple thorns, the colors signifying that the plant is healthy and optimal for laying eggs and beginning her colony. The queen must leave her thorn sometimes to harvest Beltian bodies and petiolar nectar. However, this creates a risky situation. If a thorn is left unoccupied, a new queen can claim it and begin her own colony (Janzen, 1983).

Sometimes, multiple colonies can reside in a single plant in different thorns, although this usually only happens in areas with a high density of acacia plants . One single colony is also able to enlarge and occupy anywhere from ten to thirty shoots in an area. Generally speaking, all acacia plants within one cleared basal area are occupied by a single colony. *Acacia collinsii* is native to tropical and subtropical climates (Janzen, 1983). They are frequently home to the *Pseudomyrmex* ants because of their Beltian bodies, detachable protein and lipid rich tips on the leaves of acacias. Acacias and *Pseudomyrmex* ants have formed a symbiotic relationship. In return for the plants providing the ants with sustenance and shelter, the ants viciously protect the acacia from any external forces (Lahanas, 2017). Our hypothesis is that there is a direct relationship between plant height and presence of ants. The relationships between thorn size, Beltian bodies, and ant presence will also be examined.

Materials and Methods

For this project, we began looking at acacia plants around the Achotines grounds. We measured the height of each plant with a 5-meter tape and the average length of three thorn pairs using a vernier calliper. We noted whether the Beltian bodies were mature (yellow in color) and whether or not there were ants living on the plant. We attempted to look for plants that were relatively isolated from others in order to ensure

that the data we were collecting was from acacias that had been chosen by a queen, not acacias that were only inhabited because of their proximity to other acacias. We gathered data from a pool of 20 plants, only some of which housed colonies of *Pseudomyrmex* ants. We used the computer program InStat to analyze the data we collected. To look at the correlation between height and presence of ants, we used a linear regression.

Results

A total of 20 acacia plants were examined. The data collected is presented in Table 1. The plants examined varied from 10.6 centimeters to 204 centimeters in height. Eight of the plants possessed mature Beltian bodies, and ten plants had only immature Beltian bodies. Of those plants containing ants, only one also had mature Beltian bodies.

Table 1: Raw data collected from 20 *Acacia collinsii* plants located at Achotines Laboratory

Height of Plant	Thorn 1	Thorn 2	Thorn 3	Ants Present	Beltian Bodies	Average Thorn Size
37	46.3	40	33.5	no	mature	39.93
10.6	30.3	34.2	22.1	no	mature	28.87
19	41.7	34.6	42.7	no	mature	39.67
52	50.7	43.8	48.3	yes	immature	47.60
16	27.5			no	mature	9.17
53	39.7	42.5	43.7	yes	immature	41.97
102	42.5	48.6	32.6	yes	mature	41.23
75	49	46.8	45.2	no	mature	47.00
44	27	39.1	31.9	no		32.67
54	42.5	36.1	38.2	yes	immature	38.93
104	52.2	42.3	49.4	no	immature	47.97
54	42.2	43.9	43	no	mature	43.03
25	40	40	28.6	no	immature	36.20
50	35.5	35.9	39.5	yes	immature	36.97
170	48.8	60.9	60.9	yes	immature	56.87
62	36.6	37.6	32.7	no	immature	35.63
204	45	42.3	36.9	yes	immature	41.40
200	39.6	39	44.4	no	mature	41.00

Table 2. The results from our linear regression, analyzing the relationship between height of acacia and presence of ants.

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Linear Regression

Number of points = 20

Parameter	Best-fit Value	Standard Error	95% confidence interval from	to
Slope	0.002493	0.001767	-0.001220	0.006206
Y intercept	1.308	0.1763	0.9373	1.678
X intercept	-524.53			

Correlation coefficient (r) = 0.3156. r squared = 0.09957

Standard deviation of residuals from line (Sy.x) = 0.5001

Test: Is the slope significantly different from zero?

The P value is 0.1753, considered not significant.

This result was obtained from the following ANOVA table.

Source of variation	Degrees of freedom	Sum of squares	Mean square
Linear regression (Model)	1	0.4979	0.4979
Deviations from linearity (Residual)	18	4.502	0.2501
Total	19	5.000	

F = 1.991

As shown in Table 2, with an r^2 value of 0.0996 and a P value of 0.1753, our statistical analysis indicated no correlation between acacia plant height and presence of ants.

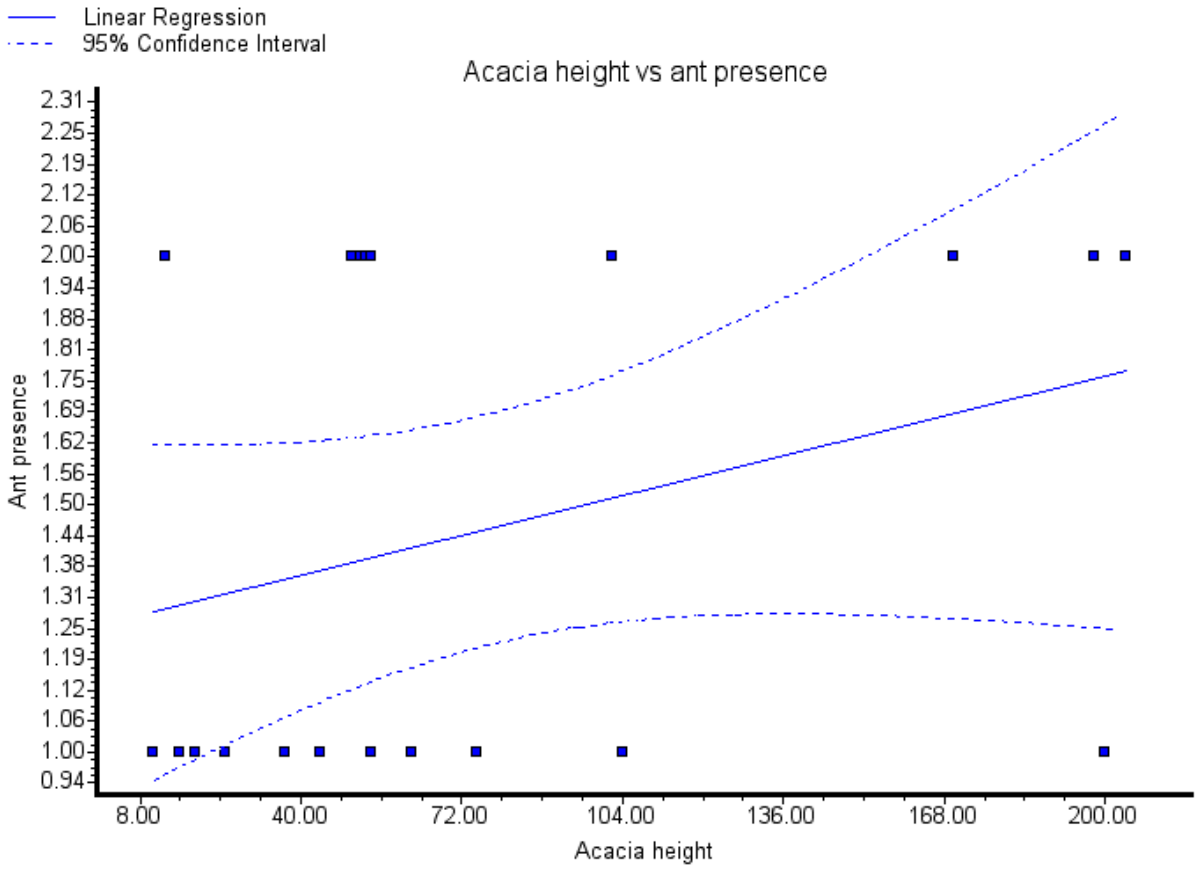

Figure 2. Graph representing the correlation between *Acacia collinsii* height and ant presence (1 on the x-axis represents no ants and 2 represents presence of ants)

Our data did not yield a result that could support our hypothesis. Our linear regression produced a P value of 0.1753. This is greater than the P value of 0.05 to be considered significant. The value 0.1753 suggests that if we were to have continued gathering data, we could have potentially supported our hypothesis, but our time was too limited.

Table 3. Second linear regression we did to examine correlation between presence of ants and average thorn size.

Linear Regression

Number of points = 20

Parameter	Best-fit Value	Standard Error	95% confidence interval from	to
Slope	0.02757	0.01511	-0.004183	0.05932
Y intercept	0.3952	0.6152	-0.8974	1.688
X intercept	-14.335			

Correlation coefficient (r) = 0.3950. r squared = 0.1560

Standard deviation of residuals from line (Sy.x) = 0.4842

Test: Is the slope significantly different from zero?

The P value is 0.0848, considered not quite significant.

This result was obtained from the following ANOVA table.

Source of variation	Degrees of freedom	Sum of squares	Mean square
Linear regression (Model)	1	0.7802	0.7802
Deviations from linearity (Residual)	18	4.220	0.2344
Total	19	5.000	

F = 3.328

After looking at the relationship between presence of ants and height of *A. collinsii*, we did a second linear regression to look at the relationship between presence of ants and average thorn size. This linear regression (shown in Table 3) yielded an r^2 value of 0.16 and a P value of 0.08, which is close to significant, but not quite.

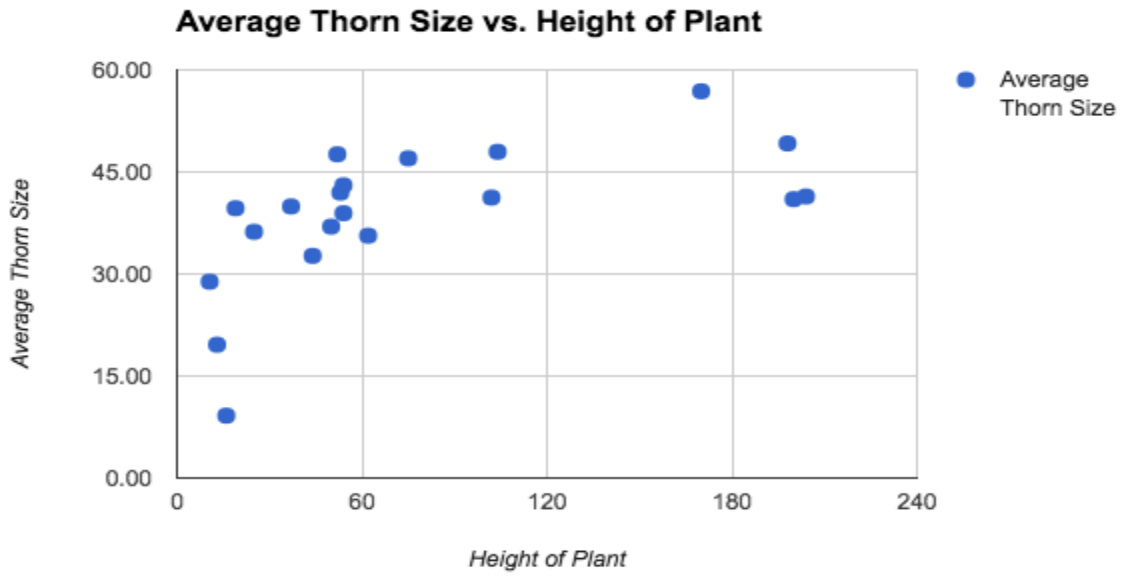

Figure 2. A scatter plot displaying the correlation between average thorn size and height of plant.

We then did a Spearman Rho test to look at the relationship between average thorn size and height of plant. As shown in Figure 2, there is a direct correlation between these two sets of data. Our test came out with a R value of 0.72 and two tailed P value of 0.00032. These figures are clearly significant.

Discussion

We found no correlation between acacia plant height and presence of height. We speculate this was due to the lack of *A. collinsii* plants around Achotines that were isolated enough to ensure that they were colonized originally. Thus, many of the plants we encountered could have been occupied by ants from neighboring plants. In these instances the plants were may well have been chosen by colonies due to their proximity to nearby acacias, rather than one that a queen had chosen to start her colony.

No correlation was found between average thorn size and ant presence, but the data was trending in that direction. The linear regression (shown in Table 3) yielded an r^2 value of 0.16 and a P value of 0.08, which is close to significant, but not quite.

This is important to our study as a queen needs to find a big enough thorn to lay her eggs. If the queen is only able to use thorns of a size large enough for her eggs, and there is a direct correlation between height of a plant and average thorn size, we can speculate that there must similarly be a relationship between the height of an acacia and whether a queen chooses to colonize it.

We also compared the data we collected for average thorn size with the data for acacia height, which came out significant. While this may seem intuitive, the correlation serves as further evidence for a relationship between ant colonization and height. Because the correlation between ant presence and thorn size was approaching significance, and the correlation between thorn size and acacia height was clearly significant, it can be inferred that if we had continued to collect data we might have found a correlation between ant presence and plant height, which was our original hypothesis.

Another interesting finding came while observing the number and maturity of Beltian bodies, we noticed that among the 9 plants housing ants, eight had immature Beltian bodies and only one had mature Beltian bodies. While we don't have enough data to draw any conclusions about the correlation between ant presence and Beltian body maturity, we can see a definite trend towards ants occupying acacias with immature Beltian bodies.

If we were to attempt this study again, we would want to have more time and data from different locations, possibly deeper into the forest. It would be interesting to compare data from locations that were closer to the Achotines lab and some locations that weren't as close to and were possibly less influenced by humans. Many of the variables that proved to be problematic during our data collecting process involved human intervention or lack of isolation for the acacias. Most of our data samples came from plants that were directly beside a road, plenty of them having been cut down, making it impossible for us to know how tall the original plant was.

To better determine if height was a deciding factor in what acacia plants the ants chose to colonize, we should have used acacias that were clearly specifically chosen by a queen, rather than ones that were in areas with a high density of acacia plants, which would mean that they could have been colonized by *Pseudomyrmex* ants moving from their original home.

Another problem we encountered was lack of time and lack of resources. Due to these constraints we were limited in how much data we could collect.

Conclusion

Overall, although our study did not reveal statistically significant results for our hypothesis, we were able to gather valuable information about the relationship between the acacia plants and *Pseudomyrmex* ants. According to our calculations, there is no correlation between plant height and ant presence and a weak correlation between average thorn size and presence of ants but a strong correlation between plant height and average thorn size.

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Works Cited

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